CLAIMS

What is claimed is:

1. A method of fabrication of a detection system that utilizes surface enhanced Raman spectroscopy (SERS), comprising:

tuning an excitation source to an extinction maximum wavelength of an analyte molecule, wherein said excitation source possesses an excitation bandwidth;

tuning surface characteristics of a substrate to optimize overlap of surface plasmon resonance wavelength (SPRW) spectrum of said substrate, said excitation bandwidth, and Raman scattered wavelengths of said analyte molecule by controlling deposition parameters associated with deposition of a material on said substrate;

processing said substrate to provide further SERS enhancement such that an SERS enhancement factor of at least 10^{14} is provided for detection of said analyte molecule, wherein said processing comprises at least one item selected from the list consisting of: enclosing said substrate in a fractal microcavity, optimizing metal-particle gap characteristics of said substrate, and chemically enhancing said substrate; and

fabricating said detection system to illuminate said substrate with said excitation source.

2. The method of claim 1 wherein said controlling deposition parameters includes controlling temperature of said substrate during deposition of said material.

3. The method of claim 1 wherein said controlling deposition parameters includes controlling parameters associated with thermal evaporation of metal material on said substrate.

4. The method of claim 3 wherein said metal material is selected from the list consisting of: Ag, Au, and Cu.

5. The method of claim 1 wherein said deposition parameters associated with at least one technique selected from the list consisting of: thermal evaporation, sputter deposition, and chemical vapor deposition.

6. The method of claim 1 wherein said substrate is selected from the list consisting of glass, metal, and dielectric material.

7. A system for detecting an analyte molecule utilizing surface enhanced Raman spectroscopy (SERS), said system comprising:

a coated capillary that includes a tuned substrate that possesses a surface plasmon resonance wavelength (SPRW) tuned according to an extinction maximum wavelength of said analyte molecule and microcavities that possess resonant modes tuned according to said extinction maximum wavelength; and

an excitation source that is tuned according to an extinction maximum wavelength of said analyte molecule and is operable to illuminate at least a portion of said coated capillary, wherein said coated capillary and said excitation source are operable to provide an SERS enhancement factor of at least 10^{14} for said analyte molecule.

8. The system of claim 7 wherein said substrate possesses metal-particle gap characteristics that are optimized for said analyte molecule.

9. The system of claim 7 wherein said substrate is operable to form a chemical bond with said analyte molecule.

10. The system of claim 7 wherein said excitation source is a coherent light source.

11. The system of claim 7 wherein said excitation source is a non-coherent light source.

12. The system of claim 7 further comprising:

a dispersive element that is operable to separate wavelength components of optical power processed by said coated capillary.

13. The system of claim 12 further comprising:

optical detectors that are operable to receive said separate wavelength components.

14. The system of claim 13 wherein said optical detectors are elements of a charge-coupled device (CCD) array.

15. The system of claim 13 further comprising:

a controller that is communicatively coupled to said optical detectors and is operable to compare spectra information received from said optical detectors to a Raman scattered spectrum of said analyte molecule.

16. A method of fabrication of a detection system that utilizes surface enhanced Raman spectroscopy (SERS), comprising:

tuning an excitation source to an extinction maximum wavelength of an analyte molecule;

tuning surface characteristics of a substrate to possess a surface plasmon resonance wavelength (SPRW) that equals said maximum extinction wavelength by controlling deposition parameters associated with deposition of a material on said substrate;

processing said substrate to provide further SERS enhancement such that an SERS enhancement factor of at least 10^{14} is provided for detection of said analyte molecule, wherein said processing comprises at least one item selected from the list consisting of: enclosing said substrate in a fractal microcavity, optimizing metal-particle gap characteristics of said substrate, and chemically enhancing said substrate; and

fabricating said detection system to illuminate said substrate with said excitation source.

17. The method of claim 16 wherein said controlling deposition parameters includes controlling temperature of said substrate during deposition of said material.

18. The method of claim 16 wherein said controlling deposition parameters includes controlling parameters associated with thermal evaporation of metal material on said substrate.

19. The method of claim 18 wherein said metal material is selected from the list consisting of: Ag, Au, and Cu.

20. The method of claim 16 wherein said deposition parameters associated with at least one technique selected from the list consisting of: thermal evaporation, sputter deposition, and chemical vapor deposition.